

Claims

[c1] What is claimed is:

1.A lowpass filter formed in a multi-layered substrate comprising:

a first capacitor formed on at least one layer of the multi-layered substrate and being electrically connected to a first node;

a first inductor being electrically connected to the first capacitor at the first node; and

a second inductor being electrically connected to the first inductor and the first capacitor at the first node;

wherein negative mutual inductance exists between the first inductor and the second inductor.

[c2] 2.The lowpass filter of claim 1 wherein each of the first and second inductors is realized in spiral form.

[c3] 3.The lowpass filter of claim 2 wherein the first and second inductors have reverse orientations for creating the negative mutual inductance between the first inductor and the second inductor.

[c4] 4.The lowpass filter of claim 2 wherein the first and second inductors have a rectangular, circular, or octagonal

shape.

- [c5] 5.The lowpass filter of claim 1 wherein each of the first and second inductors is formed on at least one layer of the multi-layered substrate.
- [c6] 6.The lowpass filter of claim 1 wherein the first capacitor is electrically connected to ground.
- [c7] 7.The lowpass filter of claim 1 wherein the effective inductance of the first inductor is equal to the inductance of the first inductor minus the mutual inductance between the first inductor and the second inductor, and the effective inductance of the second inductor is equal to the inductance of the second inductor minus the mutual inductance between the first inductor and the second inductor.
- [c8] 8.The lowpass filter of claim 1 wherein the multi-layered substrate is a low temperature co-fired ceramic (LTCC) substrate.
- [c9] 9.The lowpass filter of claim 1 wherein the first capacitor is a metal-insulation-metal (MIM) capacitor.
- [c10] 10.An n^{th} -order lowpass filter formed in a multi-layered substrate comprising:
a first capacitor formed on at least one layer of the

multi-layered substrate and being electrically connected to a first node;
a first inductor being electrically connected to the first capacitor at the first node;
a second inductor electrically connected between the first node and a second node; and
m capacitor-inductor pairs, each capacitor-inductor pair comprising a capacitor electrically connected to an initial node of the capacitor-inductor pair and an inductor electrically connected between the initial node and a final node of the capacitor-inductor pair, wherein the second node is the initial node for a first capacitor-inductor pair, and the initial node for each succeeding capacitor-inductor pair is the final node of each preceding capacitor-inductor pair;
wherein negative mutual inductance exists between inductors that are electrically connected to a common node; and
wherein $n=2*m+3$, n being an odd integer greater than one, and m being a nonnegative integer.

[c11] 11.The lowpass filter of claim 10 wherein each of the inductors is realized in spiral form.

[c12] 12.The lowpass filter of claim 11 wherein inductors that are electrically connected to a common node have reverse orientations for creating negative mutual induc-

tance between the inductors.

- [c13] 13.The lowpass filter of claim 11 wherein each of the inductors has a rectangular, circular, or octagonal shape.
- [c14] 14.The lowpass filter of claim 10 wherein each of the inductors is formed on at least one layer of the multi-layered substrate.
- [c15] 15.The lowpass filter of claim 10 wherein each of the capacitors is electrically connected to ground.
- [c16] 16.The lowpass filter of claim 10 wherein each of the capacitors is formed on at least one layer of the multi-layered substrate.
- [c17] 17.The lowpass filter of claim 10 wherein the effective inductance of each inductor in the lowpass filter is equal to the inductance of the inductor minus the mutual inductance between the inductor and each of the other inductors electrically connected to the inductor at common nodes.
- [c18] 18.The lowpass filter of claim 17 wherein there is negligible mutual inductance between each inductor in the lowpass filter and other inductors not connected to the inductor at common nodes.
- [c19] 19.The lowpass filter of claim 10 wherein the multi-

layered substrate is a low temperature co-fired ceramic (LTCC) substrate.

[c20] 20. The lowpass filter of claim 10 wherein each of the capacitors is a metal-insulation-metal (MIM) capacitor.